DIGITAL SUPPORT AND COMPLIANCE WITH SPECIFICATIONS FOR ARRANGEMENT AND FASTENING OF CARGOES

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ABSTRACT

The provision of technical specifications for arrangement and fastening of cargo in a car or a container is considered as a single technological process covering the stages of determining, developing and negotiating specifications for a particular transportation, their use during loading, processing and acceptance of cargo for shipment, control of loading en route and analyzing efficiency and reliability of applied specifications. A detailed description is given of the intelligent system tool ASKM TU, developed with participation and under the leadership of the author. The system is digitally implementing a successively structured technological process that aims to improve the level of safety and security of cargo transportation.

Keywords: railway, multimode transportation, specifications, arrangement and fastening of cargoes, digital technology, cargo and commercial activities.

Background. *Providing cargo transportation services, a carrier is obliged not only to deliver goods in time to a consignee, but also to ensure safety and security of transportation itself. The main component of this is observance of specifications for arrangement and fastening of goods in cars and containers. If they are violated, cargo may collapse en route, deformation of loading dimensions may occur, which in turn can lead to both damage to the cargo itself and to more serious consequences – to crashes and accidents.*

Carriers of all modes of transport in all countries pay much attention to the issue of arrangement and fastening of cargo. For example, in 2014, the International Maritime Organization (IMO), the International Labor Organization (ILO) and the United Nations Economic Commission for Europe (UNECE) jointly adopted IMO/ILO/UNECE Code of Practice for Packing of Cargo Transport Units (CTU Code) [1]. The Code covers all aspects of arrangement of goods in cargo containers for intermodal transportation, taking into account the requirements of sea and land transport (road and rail) and extends to transport operations throughout the logistics supply chain from the moment of stacking and securing the cargo in a container at a consignor and until the goods are taken from a container at a consignee.

Particular attention is paid to allocation of responsibility among the participants in the transportation process, including responsibility of a shipper for correct determination of a cargo transport unit suitable for a particular transportation, for correct packing and securing of cargo, correct execution of shipping documents and, ultimately, provision of cargo suitable for carriage from the point of view of ensuring its safety.

Each participating party in the chain should identify the risks of disrupting the integrity of a cargo transport unit and, if necessary, take measures to remedy the situation.

The Code does not abolish national and international rules or technical specifications for arrangement and fastening of cargoes, established for only one mode of transport.

In this article, technical specifications for arrangement and fastening cargoes in cars and containers for railway transportation are considered.

Objective. *The objective of the author is to consider digital systems that contribute to regular compliance with specifications for arrangement and fastening of cargoes.*

Methods. *The author uses factor analysis, process and managerial approaches.*

Results.

Stages of the life cycle of specifications

If we imagine the provision of specifications for arrangement and securing cargo in the framework of a single technological process, we can distinguish four main stages or stages of its life cycle, consistently passing from a consignor to a carrier, from a carrier to a consignor and then again to a carrier. These steps are enlarged in Pic. 1.

The first stage occurs long before transportation and is associated with determination by a consignor of availability of current specifications and, if necessary, development and approval of sketches, local specifications, unintended technical specifications with a carrier. This need for a consignor follows from provisions of the Federal Law «The Charter of Railway Transport» (hereinafter referred to as the Charter) [2], determining its duty to prepare cargo for transportation in order to ensure traffic safety, safety of cargo, car, container, as well as fire and environmental safety.

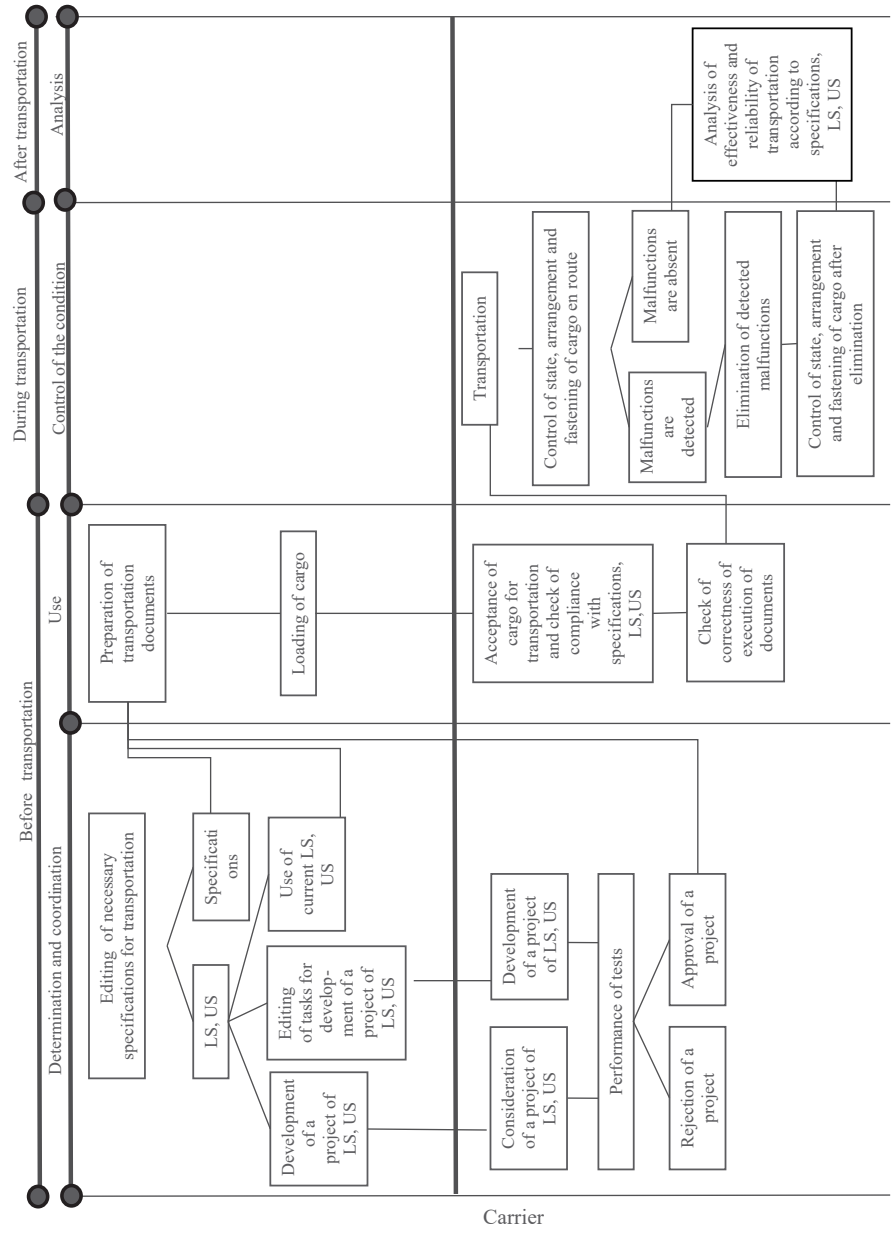
Most of all railway transportation is carried out using standard specifications. Description of loading schemes, requisites of fastening and basic requirements depending on the type of transportation is given in specifications of arrangement and fastening of cargoes in cars and containers [3], specifications for arrangement and fastening of cargoes (Appendix 3 to SMGS) [4] and the rules of loading and fastening of cargoes transported in the Russian-Finnish direct rail service [5].

If transportation parameters do not fit into standard specifications, transportation is carried out according to local or unintended specifications (hereinafter LS, US).

The consignor must determine the possibility of transportation under standard specifications, in the absence of such an opportunity, to develop LS or US and coordinate them with the carrier – JSC Russian Railways. The shipper can order the development service either in any specialized organization or directly in JSC Russian Railways.

In some cases, when using standard specifications, there is a need to prepare sketches for arrangement and fastening of cargoes, explaining the requirements of specifications. Then these sketches are coordinated with JSC Russian Railways.

Coordination or development of LS, US on the part of JSC Russian Railways involves specialists of the center of the company's transport service (CFTO) or territorial centers of company's transport services – structural subdivisions of CFTO. The coordination of sketches is the concern of the station heads.



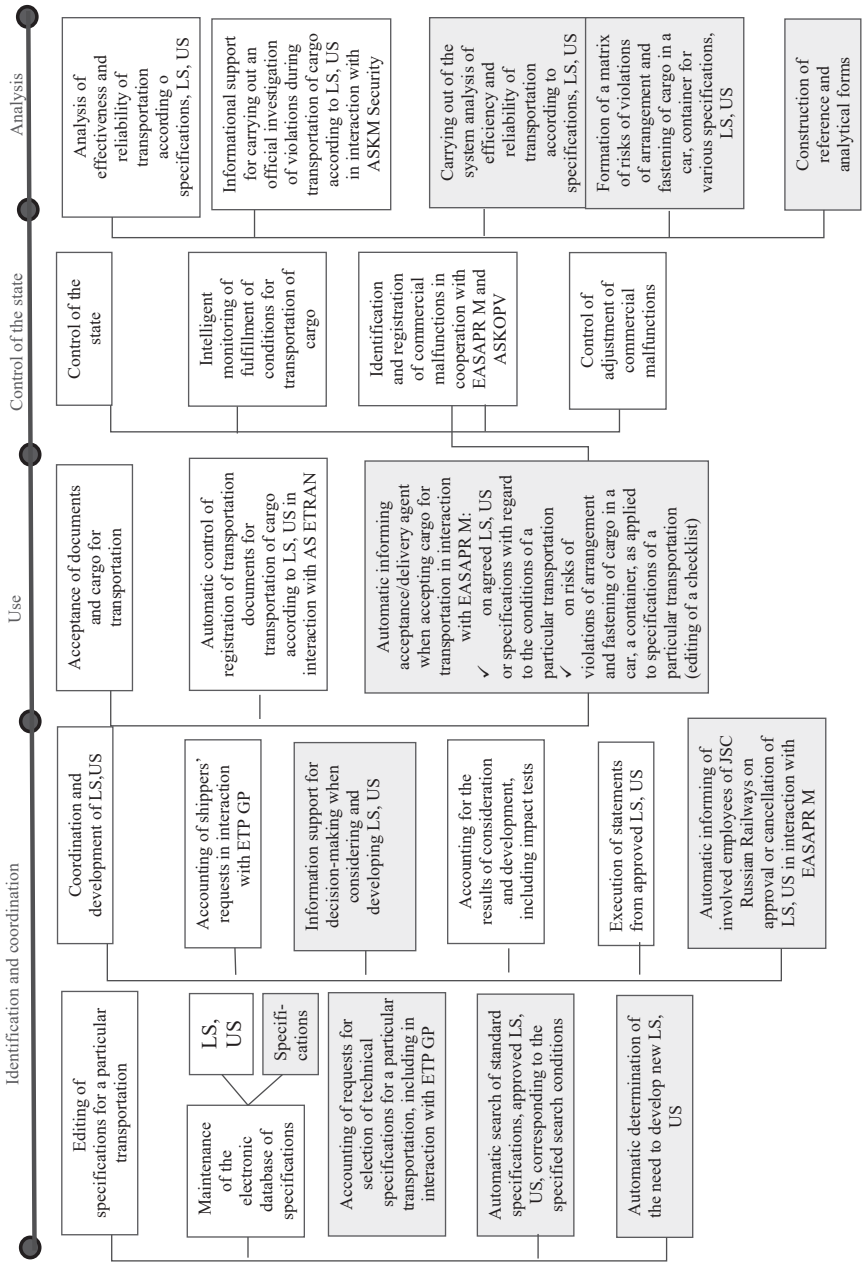
Pic. 1. Stages of a life cycle of the technological process of provision of specifications for arrangement and fastening of cargo.

The second stage is connected with correct application of the agreed specifications when loading cargo into a car and its documenting. In accordance with the requirements of the Charter of railway transport, loading is provided by a consignor. However, a carrier or other specialized organization on contractual terms can take this operation on themselves.

In any case, at this stage, in accordance with the rules of multistage control to ensure safety of train traffic when receiving cargo for carriage and en route [6], the carrier checks whether the actual specifications for arrangement and fastening of cargo in a car and a container meet the approved standard specifications, LS, US, as well as correctness of filling of a transportation document, presence of copies of orders or orders for appointment of representatives of a consignor responsible for loading and documents for attestation of their knowledge of specifications.

The third stage is control of condition, arrangement and fastening of cargo en route at the points of commercial inspection of trains and cars (hereinafter referred to as PCI) and commercial security posts (hereinafter referred to as CSP), immediate elimination of identified commercial failures threatening traffic safety, and accompanying cargo control after troubleshooting.

At the fourth stage, all identified commercial failures are analyzed with identification of causes that led to their occurrence, severity of possible



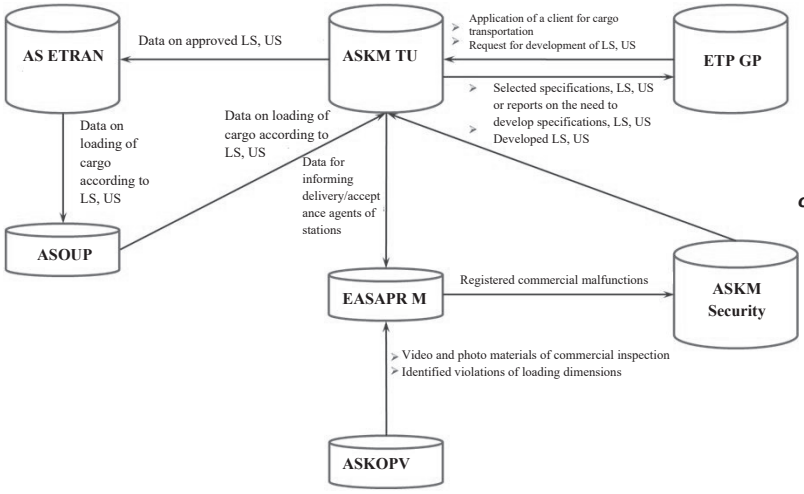
Pic. 2. Functional capabilities of ASKM TU.

consequences and determination of effectiveness and reliability of application of specifications for each scheme separately.

The full technological cycle of providing specifications for arrangement and fastening of cargo is implemented in the subsystem for monitoring and analyzing the quality of cargo transportation by local and unintended specifications (ASKM TU) as part of an automated system for operational control and analysis of the quality of commercial operations and freight security (ASKM) in cooperation with adjacent corporate – automated system of centralized preparation of transportation documents (AS ETRAN), a single automated system of claims work of the centres of commercial work in the sphere of cargo transportation (EASAPR M), automated system of commercial inspection of trains and cars (ASKOPV), automated system of operational control of transportation (ASOUP), electronic trade site «Cargo transportation» (ETP GP).

The subsystem ASKM TU was developed and put into operation in JSC Russian Railways under the guidance and with participation of the author.

Pic. 2 shows the main functionality of the subsystem ASKM TU. White color indicates the functions that are implemented and are in constant operation. Gray color highlights the functions, which are currently under development and will be put into operation at the end of this year.



Pic. 3. Scheme of information flows of ASKM TU, built on digital technologies.

The scheme of information flows of ASKM TU in interaction with participial automated systems is shown in Pic. 3.

Determination and coordination of specifications

ASKM TU provides the employees of JSC Russian Railways with the possibility to determine specifications for a particular transportation through its own interfaces, and shippers through the user interfaces of ETP GP.

The request for selection of specifications is a set of formalized description of the conditions of transportation, including the type and model of a car, type of cargo, loading gauge, length of cargo, mass of cargo and textual description of conditions of transportation, as well as rolling stock and loading conditions characterizing cargo.

When a message arrives, ASKM TU performs a syntactic analysis of text description of conditions of transportation, applying a specially developed algorithm for full-text search that allows to formalize the specified features of cargo transportation. This solution makes it possible to exclude the need to maintain multilevel regulatory and reference information, does not require the user to clearly define and accurately answer the questions posed, but allows him to enter the necessary requirements in an arbitrary form.

Further, the system searches for typical technical conditions corresponding to the specified conditions, by coincidence of formalized criteria and the computed rank of correspondence of the results of full-text search of unformalized conditions. If the search result is negative, the system checks the presence of operating LS and US using the same criteria.

Based on the results of the search, the system concludes that it is possible to use specifications, LS, US or that there is a need for new specifications. A corresponding message is formed for a user and provides either possible options for arrangement and fastening of cargo, indicating the schemes and description of details of fastening, or, if the request came from a shipper, a commercial proposal for development of new LS, US.

To realize the automatic determination of the nature of specifications for a particular transportation, an electronic catalog of typical specifications on the basis of documents [3–5] (hereinafter – electronic catalog TU) was created in the system ASKM TU. In the catalog, each set of TU corresponds to a set of formalized parameters, textual and graphic descriptions.

The electronic catalog of operating LS and US is automatically generated when specifications are approved or canceled in ASKM TU and contains drawings, a description of the binding details and explanatory notes.

ASKM TU records the full history of the project from the moment a consignor submits to RZD an application for consideration and approval or for development before its cancellation. All processes occurring during this period are taken into account, including collision tests, coordination, approval or rejection, transportation process itself, commercial faults detected during transportation, and the results of their official investigation, identifying the causes and severity of possible consequences.

The client's requests for approval of LS and US are received in hard copy and registered in the system by responsible specialists of JSC Russian Railways manually.

Client's requests for development of LS and US can be received both in paper form and electronically via ETP GP interface. In the latter case, registration is carried out automatically on the basis of the incoming message to ASKM TU.

For specialists of central or territorial units of transportation services centre, engaged in consideration and coordination of LS and US within the framework of information support for decision-making, an analysis of the existing transportation practice is provided.

For all LS and US approved, the subsystem generates statements for shippers and automatically informs employees of JSC Russian Railways. The information is also generated when the existing schemes are canceled and implemented through the user interface of EASAPR M. Thus, it becomes possible at the stations to obtain information for cargo transportation from the electronic catalog of LS, US, including the provision of loading schemes. The electronic catalog TU is available for station staff.

Use of specifications

In the framework of the multistage control of ensuring safety of cargo transportation, interaction with AS ETRAN when issuing shipping documents and EASAPR M system when receiving cargo for transportation was realized.

When issuing shipping documents, a consignor gives a CFTO agent an extract of the approved LS, US. The latter, through AS ETRAN system, requests an extract from the electronic catalog of LS, US in ASKM and reconciles the extract's data with the data submitted by the consignor in paper form. If they coincide, the agent issues shipping documents. If a discrepancy is found or the extract is not found at all in ASKM, the representative of CFTO warns the consignor and refuses to coordinate transportation.

When accepting cargo for transportation at the departure station, the delivery/acceptance agent requests in EASAPR M system for each car a checklist containing a description of control parameters that are subject to mandatory inspection in relation to specifications of transportation, information on local, unintended or standard specifications, a loading scheme and description of fastening details.

The control parameters are determined automatically according to transportation data, as well as information of the risk matrix formed in the analytical module of the system, and the system prompts the receptionist of the station on which elements of loading attention should be paid when accepting cargoes for transportation.

Monitoring the state en route

After accepting cargo for transportation, direct realization of the transportation process begins, during which ASKM TU performs intellectual monitoring of fulfillment of conditions for transportation of cargoes in cooperation with EASAPR M.

When a train passes through the electronic gates to PCI or CSP, ASKOPV system transmits to EASAPR M photo and video materials about cars and automatically detected violations of loading dimensions. The software of the RW-D weighing rail reports to EASAPM M the weighing results of each car.

All identified violations, including when conducting a commercial inspection at PCI or CSP, are compulsorily formalized by the general form acts (GU-23) in EASACM M. On the basis of the issued acts, the corresponding records of the problems that have arisen are automatically generated in the database of ASKM TU.

In case of detection of violations in arrangement and fastening of goods to in PCI, CSP, the loading is adjusted and the subsequent control is carried after adjustment. For this purpose, EASAPR M system provides the same inspection cards as when accepting cargo for transportation.

In development of ASKM system, it is envisaged to build a neural network that allows, based on the analysis of photos and results of 3D scanning of ASKOPV cargoes on an open rolling stock, to conclude that the cargo is gradually shifted relative to the means of fastening used and to car body, which will automatically diagnose situations that precede the cargo loading disorder en route.

Analysis of specifications

For each case of detecting a commercial fault at PCI and CSP, based on the messages of EASAPR M in ASKM-security system, of specialists of teritorial unit of CFTO in accordance with the approved procedure [7], an internal investigation is carried out with establishment of the causes of malfunctions, responsible units of the company and severity of possible consequences. It is difficult to determine such consequences in financial terms, since a negative event is stopped on time. In this regard, for its evaluation, quantitative rather than qualitative ranking of scenarios of events is used. Categories of the severity of the consequences are determined automatically and have five probable values: insignificant (1 point), moderate (2 points), significant (3 points), high (4 points), critical (5 points).

In cases involving arrangement and fastening of goods transported according to specification, LS, US, formalization of the problem with allocation of «bottlenecks» of loading on the basis of intellectual study of the issued acts of general form (GU-23) is automatically performed by ASKM-security system.

Based on the results of completed transportations, ASKM TU conducts a system analysis of efficiency and reliability of transportations according to specifications, LS, US. The data of intellectual monitoring of performance of specifications are used, taking into account the total volume of cargo transportation, the detected violations, their causes and severity of the consequences established by the official investigation, and also taking into account the formalized circumstances of commercial failures.

In the framework of the analysis of ASKM TU, formation of a risk matrix for violations of arrangement and fastening of cargo in a car, container for various specifications of transportation – local, unintended, standard, is carried out.

In accordance with the state standard GOST R51901.1-2002 «Risk Management. Analysis of the risk of technological systems» a risk is a «combination of probability of an event and its consequences» [8], which in this case can be interpreted as a combination of frequency of violations of arrangement and fastening of cargo in a car, container and severity of possible consequences of this violation.

The risk matrix is a tool for assessing and managing risks in the field of safety and security of cargo transportation in the area of arrangement and fastening of cargo, which involves systematic use of information to identify sources and quantify risk indicators.

The risk matrix is formed for each specification (specifications, LS, US) separately. The element of the matrix is the three-dimensional value of risk assessment – a formalized circumstance of a commercial malfunction, likelihood of its occurrence and severity of the consequences.

Commercial malfunctions associated with arrangement and fastening of cargo transported according to specifications, LS, US, which corresponds to groups 5, 6, 7 and 8 of the classifier of commercial faults of freight cars are subject to analysis [9].

The calculation is carried out for a given period of time – a month, a quarter, a half-year or a year.

For the obtained data sample, the system determines a list of specifications, LS, US used in this period and for each of them generates a risk matrix: the total number of transportations under these specifications, the total number of transport violations, the list of formalized circumstances of commercial faults, their occurrence and severity of the consequences.

The obtained value of violation probability is projected on a five-point scale having the values: unbelievable (1 point), unlikely (2 points), probable (3 points), mean probable (4 points), highly probable (5 points).

Then the received risk values are classified into three levels of danger: small (green level of danger), medium (yellow level of danger), high (red level of danger).

Risks in the red zone require special attention. They should either be eliminated altogether, or reduced to a medium or small level.

As a result of the analysis, changes can be made in the current specifications or a decision can be made to abolish their use.

By means of the received risk matrix, a checklist for receiving agents is formed as an aid in accepting goods for transportation and controlling adjustment of loading defects en route under similar specifications.

The formalized circumstances of a commercial malfunction in the checklist are converted into control parameters.

When developing the methodology for constructing the risk matrix, the provisions and requirements of the documents were used [10–12].

The methodological basis of the demonstrated analysis is contained in the methodology of automated factor analysis of the security status and reliability of the transportation process in the economy of freight and commercial operations [13].

Conclusion. *An intelligent tool based on digital technologies has been created and is being implemented within a full technological cycle to ensure the established specifications for arrangement and fastening of cargo.*

The implementation of new technologies and their accompanying techniques will positively affect the quality of cargo acceptance for transportation, operations for adjustment of loading en route, processing of transportation and other primary documents, including those compiled as necessary en route. The time of cars' stay for elimination of commercial malfunctions will reduce. All this will allow to increase the level of security and safety of freight traffic by means of automatic electronic control.

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Article received 19.03.2018, revised 24.07.2018, accepted 25.07.2018.